

ATTACHMENT 1

All Current Amendments to Amended Specification and Unamended Paragraphs

BALL GRID ARRAY PACKAGE WITH HEAT SINK DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

Please amend the paragraph beginning on line 7 of amended page 1 as follows:

¶0001 The present invention generally relates to a heat sink device applied ~~for to~~ an integrated circuit, and more particularly to a package device with a heat sink device to reduce the thermal resistance and to improve the efficiency of thermal dissipation.

2. Description of the Prior Art

Please amend the amendment to the paragraph on Page 1 from line 14 as follows:

¶0002 In the electronics and computer industries, it has been well known to employ various types of electronic package devices and integrated circuit chips, such as the PENTIUM central processing unit chip (CPU) manufactured by Intel Corporation. These integrated circuit chips have a pin grid array (PGA) package and are typically installed into a socket[[,]]. ~~which is soldered to~~ These integrated circuit chips are installed onto a computer circuit board by soldering. These integrated circuit device for example the CPU microprocessor chips, generate a great deal of heat during operation which must be removed to prevent adverse effects. The PENTIUM microprocessor contain millions of transistors, ~~which and they~~ are highly susceptible to overheating. ~~which could~~

~~destroy~~ Therefore, the microprocessor device itself or other components proximal to the microprocessor are easy to be destroyed because of overheating.

Please amend the amendment to the paragraph on Page 2 from line 4 as follows:

¶0003 In addition to the above discussion, there are many other types of semiconductor package devices, which are commonly used in computer equipment. At least some of these semiconductor package devices also have the above-mentioned problem. For example, the resistors and thermistors generate large volumes of heat during normal operation, and ~~are also subject to failure if the resistor and thermistors can not be cooled down properly~~ if the heat can not be dissipated quickly to cool down the resistors and thermistors they can be destroyed and damaged by the heat.

Please amend the paragraph on Page 2 from line 10 as follows:

¶0004 Also, the solid-state devices are commonly being installed onto a circuit board, ~~which is, in turn, or be~~ installed into a motherboard[,], or other similar primary circuit board in turn. For example, microprocessors, such as the PENTIUM II and the Celeron from Intel, are so-called “processor cards” which are installed into a motherboard of a computer in similar fashion to the way a modem is installed into a motherboard. ~~Typically, on a given~~ The existing processor card, as known, ~~[[are]]~~ has the processor semiconductor devices, such cache chips, or the like, ~~[[that]]~~ and they are necessary for the operation of the card ~~, such cache chips, or the like~~. The processor package may be installed into the processor card via a pin grid, ball grid, and land grid array and with a socket such as a ZIF or ball grid socket.

Please amend the paragraph on Page 2 from line 21 as follows:

¶0005 Similarly, according to the earlier semiconductor devices discussed above, there are many different types of electronic devices which suffer from overheating. For example, any

electronic package device may have a threat of overheating [.] ~~However, and need to be cooled down to prevent overheating. However there are many types of electronic device that need cooling; however,~~ the devices are too small to adequately support and receive the typical conventional metallic heat sink. These prior metallic heat sinks are commonly glued directly to the electronic device with a thermally conductive adhesive, or installed into the electronic package device with a mechanical structure, such as a spring clip. Further, gap pads out the interface surface between the package device and the dissipating structure are often required to ~~even out the interface surface to~~ achieve thermal dissipating efficiency. In view of the foregoing issues related to these types of electronic components, providing heat dissipation ~~dissipating~~ in the form of heat sinks, and the like, is difficult and cost prohibitive.

¶0006 The foregoing heat sink assembly of the prior art suffers from the disadvantages of having multiple components and the high cost associated therewith. These multiple component heat sink assemblies typically include expensive machined or extruded heat conductive metal, such as aluminum. Other parts, such as springs or addition clips require separate machining steps and/or molds for production. Therefore, these assemblies and methods are completely inappropriate for most electronic devices.

Please amend the amended paragraph on Page 3 from line 21 as follows:

¶0007 FIG. 1 and FIG. 2 illustrate a [[the]] conventional ball grid array package 100 with heat slug. The ball grid array package device with heat slug includes a ball grid array substrate 102, a chip or die 104 that is located on the ball grid array substrate 102, and a modified heat slug 106 that is positioned over the chip 104 and the ball grid array substrate 102. Then, a molding compound 108 is injected into the ball grid array package device 100 to ~~perform~~ accomplish the ball grid array ~~package device manufacturing packaging process~~. ~~Referring~~ referring to FIG. 2, the die or chip 104 is covered by the molding compound 108, and the heat dissipating path is restricted by the low thermal conductivity of the molding compound 108. So the ball grid array package device 100 is too

~~low to cause the can not get good~~ heat dissipating efficiency ~~would be limited by the heat dissipating path.~~ The solution ~~method added~~ of this problem is to add an embedded heat slug 108 onto the die or chip 104 to increase the heat dissipating area. Nevertheless, the defect of this technique is that if the die or chip 104 ~~would~~ generate a large volume of heat, ~~[[that]]~~ the heat cannot be removed to the environment sufficiently to reduce the operating temperature of the die or chip 104. Therefore, the chip or die 104 cannot be operated.

SUMMARY OF THE INVENTION

Please amend the paragraph on Page 4 from line 17 as follows:

¶0008 It is an object of this invention is to provide a ~~heat sink body~~ package device with a heat ~~dissipating~~ sink assembly ~~members~~ thereon, wherein the heat sink ~~[[body]]~~ assembly is ~~formed~~ made by casting to increase the heat ~~dissipation~~ ~~[[effect]]~~ dissipating efficiency.

Please amend the amended paragraph on Page 4 from line 21 as follows:

¶0009 It is another object of this invention is to provide a ~~conductive protruding thermal~~ block on the backside of the first heat sink ~~[[body]]~~ assembly to associate the cavity of the ball grid array package device with modified embedded heat slug to improve the heat dissipating efficiency.

Please amend the amended paragraph on Page 5 from line 2 as follows:

¶0010 It is a further object of this invention is to provide at least two ~~conductive thermal~~ supports on the backsides of first heat sink ~~[[body]]~~ assembly to join the ~~through holes~~ openings of the ~~bottom plate~~ second heat sink assembly.

Please amend the amended paragraph on Page 5 from line 6 as follows:

¶0011 It is yet another object of this invention is to provide a ~~bottom plate~~ second heat sink assembly to join at least two ~~conductive~~ thermal supports of the first ~~[[the]]~~ heat sink assembly ~~with the at least two conductive supports to contact with~~ attach the backside of the printed circuit board to ~~introduce~~ dissipate the heat ~~which is generated by the die or chip. The heat can be removed~~ from the backside of the printed circuit board through the ~~bottom plate~~ second heat sink assembly to ~~[[the]]~~ at least two ~~conductive~~ thermal supports of the first heat sink assembly ~~to the heat dissipating structure.~~

Please amend the amended paragraph on Page 5 from line 14 as follows:

¶0012 According to abovementioned objects, the present invention provides the heat sink device for the ball grid array package device with a modified embedded heat slug to improve the heat dissipating efficiency. The heat sink device is constructed of first heat sink assembly and the second heat sink assembly. The first heat sink assembly includes ~~a heat dissipation that located above the heat sink body, and~~ at least two ~~conductive~~ thermal supports that located ~~[[below]]~~ under the two sides of the first heat sink ~~[[body]]~~ assembly, which is used to increase the heat dissipating area. A ~~conductive protruding~~ thermal block located below the backside of the heat sink ~~[[body]]~~, and the ~~conductive protruding~~ thermal block associated with the cavity of the ball grid array package device with modified embedded heat slug to increase the heat dissipating efficiency. In addition, the second ~~[[the]]~~ heat sink assembly is a bottom plate, which includes ~~[[the]]~~ a protruding structure in the ~~central~~ center of the ~~bottom plate~~ second heat sink assembly, and at least two ~~through holes~~ openings on the two sides of the ~~bottom plate~~ second heat sink assembly respectively. The protruding structure ~~contacted with~~ attached to the backside of the printed circuit board to increase the efficiency of heat dissipating and to remove the heat that is generated from the die or chip. ~~[[,]] therefore, the heat is generated die or chip that can be removed by the~~

dissipation, ~~In addition, and to join the~~ at least two openings of the second heat sink assembly joined at least two ~~conductive~~ thermal supports of the first heat sink ~~[[body]]~~ assembly to fix the first heat sink assembly, the second heat sink assembly, and the ball grid array package device, in which the ball grid array package device positioned ~~on the printed circuit board~~ that between the first heat sink assembly and second heat sink assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

¶0013 The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

Please amend the paragraph on Page 6 from line 20 as follows:

¶0014 FIG. 1 is a schematic ~~representation~~ that shows the lateral view of device of the ball grid array package device with the modified embedded heat slug in accordance with the prior conventional technique;

¶0015 FIG. 2 is a schematic representation the cross-section view of device of the ball grid array package with modified embedded heat slug in accordance with the prior conventional technique;

Please amend the amended paragraph on Page 7 from line 4 as follows:

¶0016 FIG. 3 is a schematic that shows the cross-sectional view of the structure of a first heat sink assembly that includes ~~a heat sink body~~; a first heat sink structure ~~dissipation~~ thereon, at least two ~~conductive~~ thermal supports located ~~[[below]]~~ under two sides of the heat sink body, and a ~~conductive protruding~~ thermal block that located ~~[[below]]~~ on the backside of the first heat sink structure ~~[[body]]~~ in accordance with the device disclosed herein;

Please amend the amended paragraph on Page 7 from line 11 as follows:

¶0017 FIG.4 is a schematic that shows the cross-sectional view of the thermal conductive adhesive tape spread overall the surface of backside of the first heat sink ~~[[body]]~~ structure to fix and to increase the heat dissipating efficiency in accordance with the device disclosed herein;

Please amend the amended paragraph on Page 7 from line 16 as follows:

¶0018 FIG.5 is a schematic that shows the cross-sectional view of the structure of the ball grid array package device with modified embedded heat slug on the printed circuit board in accordance with the device disclosed herein;

¶0019 (Deleted paragraph on Page 7 from line 21)

Please amend the amended paragraph on Page 8 from line 2 as follows:

¶0020 FIG. 6 is a schematic that shows the cross-sectional view of the structure of the second heat sink assembly in accordance with the device disclosed herein;

Please amend the amended paragraph on Page 8 from line 6 as follows:

¶0021 FIG. 7 is a schematic that shows the cross-sectional view of the ~~conductive thermal~~ support of the heat sink body passed through the at least two through holes of the printed circuit board to fix the printed circuit board in accordance with the device disclosed herein; and

Please amend the amended paragraph on Page 8 from line 11 as follows:

¶0022 FIG. 8 is a schematic that shows the heat dissipating is introduced from the printed circuit board to the heat sink assembly in accordance with the structure disclosed herein.

¶0023 Some sample embodiments of the invention will now be described in greater detail. Nevertheless, it should be recognized that the present invention can be practiced in a wide range of other embodiments besides those explicitly described, and the scope of the present invention is expressly not limited except as specified in the accompanying claims.

Please amend the paragraph on Page 8 from line 24 as follows:

¶0024 The present invention provides the package device with modified embedded heat slug to reduce the thermal resistance and to increase the heat dissipating capability. The package device can be a ball grid array package device. FIG. 3 through FIG. 7 illustrates the structure, function, and the relationship there-between of the heat sink device, and FIG. 8 represents the heat-dissipating path ~~according to~~ of the heat sink device ~~as provided in~~ of the present invention. FIG. 3 represents the structure of the first heat sink assembly 1A, which includes a first heat dissipating structure 2 and a second heat dissipating structure 4. The second heat dissipating structure 4, such as a heat dissipating fin, ~~located~~ is disposed on the

first heat dissipating structure 2. The second heat dissipating structure 4 is used to increase the heat dissipating area to improve the heat dissipating efficiency. At least two thermal supports 6 are located on the backside of the first heat dissipating structure 2, and are insertable through holes 14 in a printed circuit board 12 (as shown in FIG. 8). ~~[[that]]~~ The first heat dissipating structure 2 is attached to the package device with a modified embedded heat slug on the printed circuit board (as shown in FIG. 5), and is connected with the second the heat sink assembly (as shown in FIG. 4).

Please amend the paragraph on Page 9 from line 17 as follows:

¶0025 The key feature of the present invention is that the first heat dissipating structure 2 is made of conductive material such as metal, and is made by casting, therefore, the heat dissipating efficiency would be improved. Another key feature of the present invention is that at least two thermal supports 6 located on the backside of the first heat dissipating structure 2 ~~that replaced~~ are used instead of the conventional plastic supports ~~on the backside of the first heat dissipating structure 2~~ to increase the heat dissipating efficiency.

Please amend the paragraph on Page 10 from line 2 as follows:

¶0026 ~~As referring~~ Referring to FIG. 3, the first heat ~~[-]~~ dissipating structure 2 further includes a thermal block 8 on the backside of first heat dissipating structure 2. The thermal block 8 contacts with the walls defining cavity 24 of the package device with modified embedded heat slug to increase the heat dissipating efficiency. When a ~~[[,]]~~ when the large quantity ~~number~~ of heat is generated during the operation of the integrated circuit, the thermal block 8 helps to dissipate the heat. In an alternative preferred embodiment, the thermal conductive adhesive tape 10 is spread overall the surface of backside of the first heat dissipating structure 2 (as shown in FIG. 4). The thermal conductive adhesive tape 10 ~~that~~

~~contacted~~ is connected with the surface of the molding compound 26 of the package device and to introduce the heat conductivity to increase the heat dissipation efficiency.

Please amend the paragraph on Page 10 from line 15 as follows:

¶0027 FIG. 4 shows another alternative embodiment of the present invention. The thermal conductive adhesive tape 10 is located on the backside of the first heat dissipating structure 2 in which the thermal conductive adhesive tape 10 is spread around the backside of the first heat dissipating structure 2, ~~besides~~ except the thermal block 8. The ~~key feature of the present invention is that the~~ thermal block 8 on the backside of the first heat dissipating structure 2 ~~[[is]]~~ can be an inseparable unitary member with the first heat dissipating structure 2, and located on the backside of the first heat dissipating structure 2; or added on the backside of the first heat dissipating structure 2.

Please amend the paragraph on Page 11 from line 2 as follows:

¶0028 FIG. 5 ~~represents~~ illustrates the structure of the package device with modified embedded heat slug on the printed circuit board. The structure includes a ball grid array package substrate 20~~[[,]]~~ and a modified embedded heat slug 22. The modified embedded heat slug 22 is ~~[[that]]~~ located on the ball grid array package substrate 20, and the modified embedded heat slug 22 ~~having~~ has a cavity 24 therein, ~~which is used in order~~ to reduce the thickness of the molding compound 26 ~~when the molding compound is mold into the ball grid array package device.~~ In addition, the plurality of balls 28 are located ~~[[below]]~~ under the ball grid array package substrate 20 to connect with the printed circuit board 12. Furthermore, the printed circuit board 12 includes at least two holes 14 therein to permit at least two thermal supports 6 to pass through ~~the at least two thermal supports 6.~~

Please amend the amendment of the paragraph on Page 11 from lines 14 as follows:

¶0029 In another embodiment, ~~[[when]]~~ the first heat dissipating structure 2 does not have any thermal support 6, and the printed circuit board 12 ~~did not~~ does not have ~~[[two]]~~ any holes 14 therein, ~~to provide the thermal support 6 to pass through, the~~ Only the thermal block 8 ~~[[can]]~~ assembles with the cavity 24 of the heat slug. ~~[[Also]]~~ Furthermore, ~~[[the]]~~ a conductive material can be used as an adhesive material to adhere the first heat dissipating structure 2 and the ball grid array package device 22.

Please amend the amendment of the paragraph on Page 11 from line 23 as follows:

¶0030 FIG. 6 ~~represents~~ illustrates the structure of the second heat sink assembly 1B. The second heat sink assembly 1B is a bottom plate, which has at least two openings 34 on the two sides and a protruding structure 32 of the center of the bottom plate 1B. At least two openings 34 joined with at least two thermal supports 6 in order to fix the first heat sink assembly 1A and the second heat sink assembly 1B. ~~[[,]]~~ And the openings 34 joined with the thermal supports 6 and the first heat sink assembly 1A that is fixed with the second heat sink assembly 1B by the groove 7 on the side of the at least two thermal supports 6 and the blot 36 of the two openings 34.

Please amend the amendment of the paragraph on Page 12 from line 9 as follows:

¶0031 Furthermore, the protruding structure 32 ~~of the center 32 of the bottom plate 1B~~ can attach to the backside of the printed circuit board 12, therefore, the heat can be ~~removed~~ transferred from the bottom plate 1B through at least two thermal supports 6, and the second heat dissipating structure 4 to the outside. The advantage of the abovementioned description is that the heat dissipating space of the backside of the printed circuit board 12 can be increased to improve the heat dissipating efficiency. Moreover, the second heat sink

structure 4 can use for the conventional BGA (ball grid array) package device or TEBGA (thermal enhanced ball grid array) package device without using thermal block 8.

Please amend the amendment of the paragraph on Page 12 from line 20 as follows:

¶0032 FIG. 7 ~~represents~~ shows how the first heat dissipating structure 2 is fixed with the printed circuit board 12. ~~[[the]] The~~ thermal supports 6 of the first heat dissipating structure 2 ~~[[that]] passed pass~~ through the holes 14 of the printed circuit board 12 to fix the backside of printed circuit board 12 ~~[[to]] with~~ first heat dissipating structure 2. ~~According to the~~ In view of the mechanical design, ~~at least two the~~ thermal supports 6 do not contact with the hole-wall of the holes 14, because there is a tolerance between at least two thermal supports 6 and the hole-wall of the hole 14. Nevertheless, the objective of the present invention is to improve the heat dissipating efficiency, thus the tolerance will reduce the heat dissipating efficiency. Therefore, after the thermal supports 6 are passed through the hole 14 of the grounded plane 12A is passed through by the thermal supports 6, and the , ~~conductive material 42 is filled with the gap space between the hole-wall of holes 14 and at least two the~~ thermal supports 6 are raised .

Please amend the amendment of the paragraph on Page 13 from line 9 as follows:

¶0033 Therefore, the heat can be removed from the grounded plane 12A of the printed circuit board 12 to ~~at least two the~~ thermal supports 6 by the conductive material 42. And then, ~~[[and]] the heat is~~ transferred form the thermal supports 6 and through ~~[[to]] the first heat dissipating structure 2~~ to the environment. On the other hand, the heat also can be removed from the ball grid array package device through the heat slug 22 ~~of the ball grid array package device to,~~ the second heat sink assembly 1B, ~~[[to]] at least two thermal supports 6,~~ and ~~[[to]] the grounded plane 12A of the printed circuit board 12~~ to the environment. Moreover, the heat sink assembly also can be used only with at least two thermal supports 6, and at least two springs, but without the bottom plate 1B.

Please amend the amendment of the paragraph on Page 13 from line 19 as follows:

¶0034 ~~The key feature of the embodiment, bottom plate~~ second heat sink assembly 1B is made of a ~~[[the]]~~ conductive material or metal, and the second heat sink assembly 1B has the protruding structure 32 attached to the heat slug 22. ~~[[,]] therefore~~ Therefore, the heat can be transferred to the environment by the ~~bottom plate second heat sink assembly 1B can~~ increase to improve the heat dissipating efficiency ~~[[for]]~~ of the package device. Furthermore, the second heat sink assembly 1B further includes at least two springs 40 that put around at least two thermal supports 6 to pull ~~tight between~~ the first heat sink assembly 1A and the second heat sink assembly 1B tight for the heat dissipating between them.

Please amend the amendment of the paragraph on Page 14 from line 3 as follows:

¶0035 FIG. 8 ~~represents the~~ is cross-sectional view of the construction of the package device with heat sink device 1. The heat would be generated from the chip or die during the computer is operated, thus the heat should be removed to reduce the operating temperature to keep the computer operating stability. The heat can be removed by ~~the first one heat dissipating path~~. The ~~[[first]]~~ heat dissipating path is formed by the heat to the heat slug 22, the thermal block 8, first heat dissipating structure 2, and second heat dissipating structure 4. ~~that the~~ The heat is removed from the chip and transferred through by introducing the heat to the heat slug 22 of package device to the thermal block 8, first heat dissipating structure 2, and second heat dissipating structure 4 to the environment. ~~On the other hand, There is another heat dissipating path of the package of the present invention. This heat dissipating path is formed by the backside of the printed circuit board 12, the thermal supports 6, the first heat sink assembly 1A and the second heat sink assembly 1B. The heat is removed from the chip and transferred through the second path is that the heat also can be removed from the backside of the printed circuit board 12, that passed through to the thermal supports 6, [[to]]~~

the first heat sink assembly 1A, or ~~passed~~ transferred through down through [[to]] at least two springs 40, [[to]] at least two openings [[32]] 34 of two sides of the ~~bottom plate~~ second heat sink assembly 1B, and [[to]] the printed circuit board grounded layer 12A to the environment.[[,]] There is still another heat dissipating path of the package of the present invention. This heat dissipating path is formed by the backside of the printed circuit board 12 and the protruding structure 32 of the second heat sink assembly 1B. ~~or the~~ The heat also can be removed from the chip and transferred through the backside of the printed circuit board 12, through the protruding structure 32 of the ~~bottom plate~~ second heat sink assembly 1B, [[to]] and the printed circuit board grounded [[layer]] plane 12A to the environment.

¶0036 Although specific embodiments have been illustrated and described, it will be obvious to those skilled in the art that various modifications may be made without departing from what is intended to be limited solely by the appended claims.

BALL GRID ARRAY PACKAGE WITH HEAT SINK DEVICE

ABSTRACT OF THE INVENTION

Please amend the amendment to the Abstract on Page 21 as follows:

The present invention provides ~~[[the]]~~ a heat sink device for the package device to improve the heat dissipating efficiency. The heat sink device includes a first heat sink assembly and a second heat sink assembly. The first heat sink assembly that includes has a first heat dissipating structure, a second heat dissipating structure above first the heat dissipating structure, at least two thermal supports on the backsides of the first heat sink assembly and a thermal block on the backside of the first heat sink assembly. The second heat sink assembly has a protruding structure and at least openings. The first heat sink assembly is fixed with the second heat sink assembly to form a heat sink device by the combination of the thermal supports and the openings. The first heat sink assembly and the second heat sink assembly are attached to the integrated circuit device separately by the thermal block and the protruding structure. This sink device provides several heat dissipating pathes by the second heat dissipating structure, the thermal supports, the thermal block, and protruding structure. Therefore, the heat dissipating efficiency of the heat sink device is improved. to increase the heat dissipating area. At least two thermal supports located on the backsides of the first heat sink assembly, which used to fix the heat sink assembly with printed circuit board and also conduct the heat from thermal source to heat dissipating structure. A thermal block located on the backside of the first heat sink assembly, wherein the thermal block used to associate with the cavity of the package device to increase the heat dissipating efficiency. In addition, the center structure of the second heat sink assembly attached to the backside of the printed circuit board to increase the heat dissipating efficiency to remove the heat that is generated from the die or chip that located on the printed circuit board.